

PROJECT LEAD THE WAY

INTERIM RESEARCH REPORT

DECEMBER 2011



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About this Report:

The principal investigators of the Iowa Project Lead the Way evaluation submit an interim report on the longitudinal evaluation of Project Lead The Way in Iowa.

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Executive Summary

The Iowa Department of Education, The University of Iowa, and Iowa State University have cooperated to execute the evaluation of Iowa Project Lead The Way. The research team provides this interim report to communicate the recent and preliminary findings of a longitudinal evaluation of Project Lead The Way.

- Prior research indicated that Project Lead The Way participants were more likely to be white males who performed well on achievement exams and less likely to be eligible for free or reduced lunches.
- A current working paper finds that Project Lead The Way has modest impact on mathematics scores and a small impact on science scores. However, this impact may be indirect through enticing participants to take more math and science classes than non-participants who have similar demographic and academic characteristics.
- Participants were more likely to graduate high school than similar non-participants.
- Project Lead The Way students were more likely to attend a 2-year college compared to no college, but there was no discernible effect on attending a 4-year college.

Report

Project Lead the Way (PLTW) is a growing problem-based learning program spreading throughout high schools in the United States. The goal of PLTW is to promote student interest in engineering and other STEM careers by providing hands-on coursework in pre-engineering and design as well as specialized instruction various STEM related areas while promoting growth in critical thinking and reasoning skills in students. PLTW seeks to stem the declining basic skill levels of math and science in our high school graduates and prepare students for a high tech, high skill global economy.

The Kern Family Foundation and the Iowa Mathematics and Science Education Partnership (IMSEP) funded a research grant to the Iowa Department of Education, University of Iowa, and Iowa State University to conduct an evaluation of Iowa Project Lead The Way. The evaluation compares student outcomes between Project Lead The Way participants and nonparticipants over a five-year period.

Several statewide educational data sets were combined in order to track students from secondary institutions to higher education, which is the first known study to take place in Iowa. The Iowa Department of Education's K-12 dataset, known as Project EASIER, was merged with Iowa Department of Education's Community College Management Information System (MIS) and National Student Clearinghouse. As students transition to higher education, The PLTW database is currently being merged with additional data from the National Student Clearinghouse which will give an insight on their major.

The Interim Research Report released in July 2009, summarized descriptive data related to the demographics of PLTW

students, taking math and science courses, and growth in achievement scores.¹

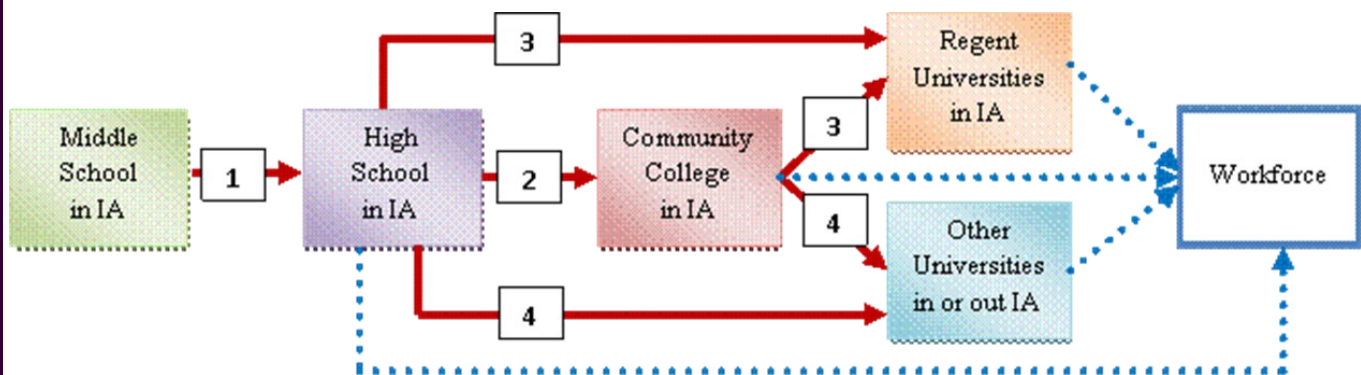
The descriptive data described in the 2009 Interim Research Report indicated Project Lead The Way students are more likely to be white, male, and strong in the area of math and sciences. Whites and Males were overrepresented in Project Lead The Way compared to their peers—students in the same grade and school districts, but female participation did show growth in the younger cohorts. Eventual Project Lead The Way students performed substantially higher than their peers in math and science *before* enrolling in the program.

A working paper has been released in fall 2011 on the impact of PLTW on Iowa's achievement exams.² A careful analysis showed PLTW appeared to have a moderate effect on mathematics scores between 8th and 11th grade while it had a small impact on science scores.

The paper also noted that PLTW students were more likely to enroll in high-level math and science courses than similar students from the same school district. Once accounted for, the math and science scores seemed to explain the increase in achievement scores instead of PLTW. Therefore, it is possible PLTW increases math and sciences scores indirectly through encouraging students to enroll in additional math and science courses.

This report presents the initial findings to answer the following questions:

1. Are Project Lead The Way students more likely to graduate from high school?
2. Are Project Lead The Way students more likely to transition into higher education?

Figure 1. Progress of Project Lead The Way Students from High School to College

This report presents a preliminary analysis of the effects of PLTW participation on students in high school through their transition to higher education. Using the 2009 cohort of high school graduates from participating PLTW districts, it also continues to analyze cognitive improvement for PLTW participants versus non-participants and provides further analysis of the characteristics associated with students most likely to participate in Project Lead The Way.

Data Set

Four data sources were merged to form the PLTW dataset. Figure 1 shows the capability of the research team to follow students from 8th grade through college. Several different data sets are used to construct this timeline, which is listed on the bottom of the figure.

First, the Iowa Department of Education houses two databases: (1) Project EASIER; and (2) the Community College MIS. Project EASIER contains data on K-12 students starting, with the exception of course data, in 2005. This data set includes information on which students enrolled in PLTW courses, their academic performance, standardized test scores (Iowa Test of Basic Skills, ITBS and Iowa Test of Educational Development, ITED), and other data. Individual course enrollment is available for all students starting in 2006.

The department maintains the Community College MIS, which is a comprehensive database of students enrolled in Iowa's 15 community colleges. The database contains demographic information, the courses in which the student is enrolled, their course program, and other educational and demographic data.

Lastly, the department has access to the National Student Clearinghouse (3 & 4)—a database of students enrolled at over 3,000 higher education institutions. The research team will be able to track high school and community college students to over 3,000 post-secondary institutions in the United States.

Summative Assessments

The State of Iowa requires at least two summative tests—which measure comprehensive knowledge in a subject area—for 8th grade and above—the Iowa Test of Basic Skills (ITBS) for 8th graders and Iowa Test of Education Development (ITED) for high school juniors. Since students do not choose to enter Project Lead The Way until high school, the ITBS scores indicate a student's cognitive ability *before* PLTW.

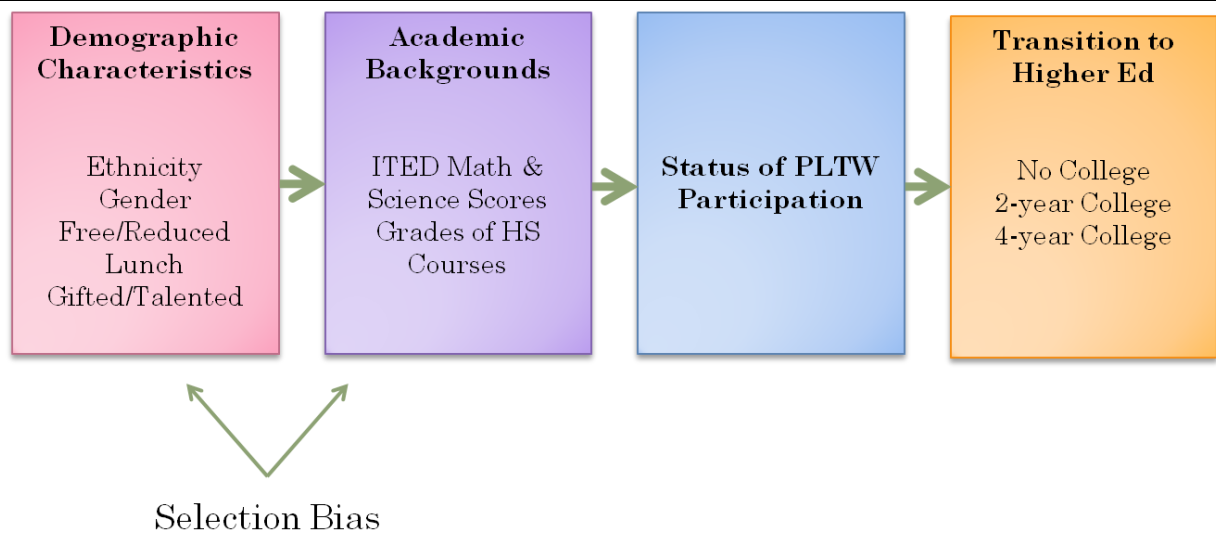
The primary focus for researchers will be the performance on the math and science sections of both tests. Since PLTW is intended to improve achievement in science, technology, engineering, and mathematics (STEM)-related fields, these areas will measure cognitive ability and improvement.

Method

By analyzing Project EASIER's course information, students who were enrolled in a PLTW course were identified and denoted as a participant. A "control cohort" was chosen from students who were enrolled a school which offered PLTW, but were not actually enrolled in any PLTW courses.

Students have been typically tracked and analyzed by graduation cohorts. Each cohort is based on the year

Figure 2. Demographics of PLTW and Non-PLTW Students in 8th Grade: 2009 Cohort

Figure 2. Demographics of PLTW and Non-PLTW Students in 8th Grade (before high school)

students are expected to graduate. Thus, each cohort has similar ages, equivalent opportunity to participate in Project Lead the Way, and face the same school environment. Four cohorts have been identified in this study—the class of 2008, 2009, 2010, and 2011.

Since the earliest available data was 2005, researchers have educational data on the class of 2008's entire high school enrollment, while researchers only have middle school information from the class of 2011. Researchers will continue to measure student outcomes as they progress through the school system.

As noted in our descriptive analysis of the demographics and academic backgrounds, PLTW participants were more likely to be male and white compared to a control group consisting of their peers. They also performed much better on summative assessments in the 8th grade prior to participating in PLTW. These differences can be defined as selection bias (Figure 2).

Our predictive model takes the demographic characteristics of the student, such as ethnicity, gender and economic status, and relates that to the academic background of the students. We then looked at how demographic characteristics impact their academic backgrounds. The next step was to understand how the academic background, with those demographic characteristics in mind, impact participation in PLTW.

Finally, we examined how PLTW participation impacts a student's likelihood to transition to higher education by executing a multinomial logit regression analysis.

To account for selection bias, researchers utilized matching techniques to take into consideration these traits for PLTW participants and match those traits with non-PLTW participants. Prior research showed that this bias can be balanced by using propensity scores.³ Students with similar propensity scores are matched, while unmatched students are removed from the sample being analyzed. This ensures comparisons between like individuals who have similar demographic characteristics as well as similar academic backgrounds. For a basic example, a white, female participant with a very high 8th grade test score who is a PLTW participant would be matched with a non-participant in the control group with the same characteristics. The complete methodology is described in a research paper developed by the research team that has been submitted for review at a leading STEM education journal.⁴

Though decreasing the overall sample size, this process helps to ensure validity in the conclusions achieved through statistical analysis. In conducting this analysis, the 2009 cohort sample was utilized, three matching techniques were applied to the sample, and statistical analysis to the narrowed sample was administered.

Definition & Terms

Immediate Enrollment - Students who enroll in higher education within the next academic year (between August and May) for more than 30 days.

Higher Education - A postsecondary institution, 4-year, 2-year, or trade college; both public, private, and proprietary (for-profit).

PLTW Participant - A student who enrolled in one or more Project Lead The Way course at any point throughout high school.

Control Group - Students who did not enroll in Project Lead The Way, but attended a school with the program available and has similar demographic or achievement scores as a PLTW participant.

Non-participant A student who attended a district with

PLTW, but did not enroll in high school and may not have the same demographic or achievement scores as a PLTW participant.

Free Lunch Eligible - Children from families with incomes less than 185 percent below poverty level qualify for free lunches from the school district. Families must apply for this program and is potentially under-reported.

Reduced Lunch Eligible - Children from families with incomes less than 130 percent below poverty level but greater than 185 percent below poverty level qualify for free lunches from the school district. Families must apply for this program and is potentially under-reported.

High School Graduation Results

Iowa has historically had higher graduation rates than the rest of the United States, which was at 87% in 2009. In order to understand PLTW's impact on high school graduation, we followed the "class of 2009"—students who were expected to graduate in 2009 based on the year the student entered high school. Whether the student graduated in or before 2009 was recorded for the study. Since earlier data indicated substantial differences between PLTW and non-PLTW students before high school, we analyzed the matched cohort of students to estimate the impact of PLTW on high school graduation.

The "matched cohort" were high achieving students, with 95% of PLTW participants graduating within four years. The set of similar non-participants had a graduation rate of 92 percent.

Preliminary analysis estimates that PLTW increases the odds of graduating high school between 90 to 120 percent. This translates to an estimated increase in the graduation rate between 1 to 3 percent amongst the matched cohort (Figure 3).

The estimated impact of PLTW on graduation rates does differ depending on the student's gender and 8th grade achievement scores. PLTW had a greater estimated

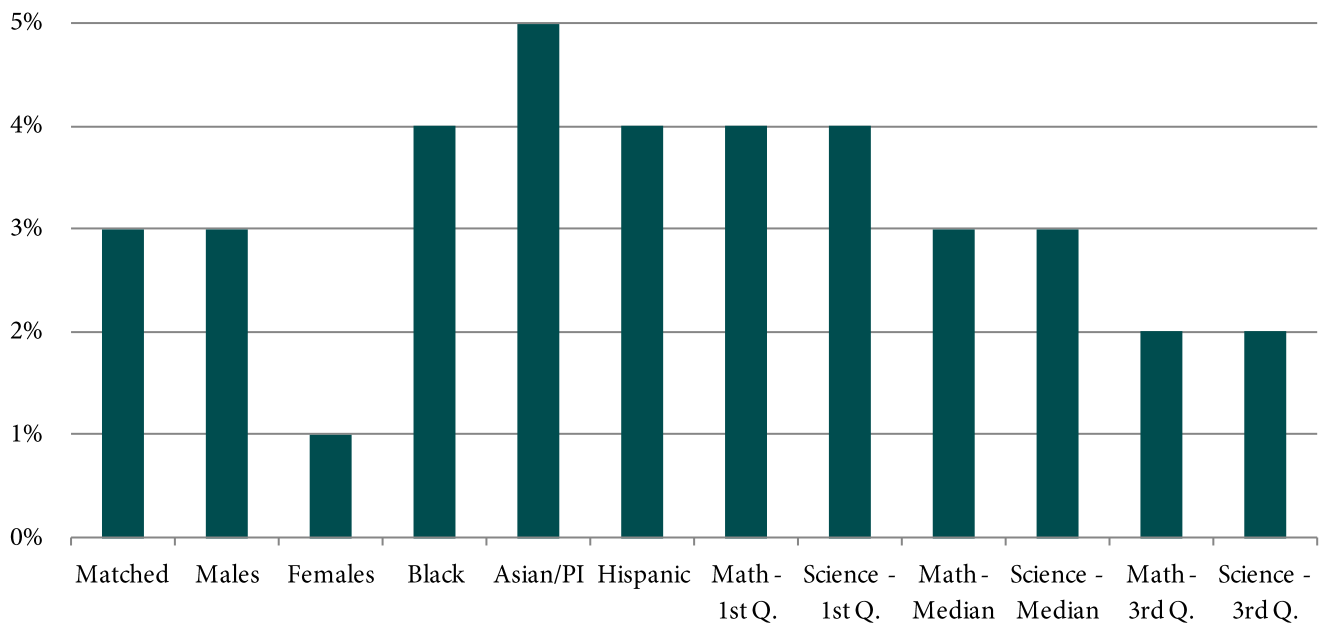
impact on males (3% increase) than females (1% increase).

Students who scored at near the bottom of the 8th grade math and science achievement exams were estimated to derive a greater benefit from PLTW. Students who scored below the first quartile relative to other PLTW students were 4 percent more likely to graduate within four years. Meanwhile, students who scored in the upper quartile only had a one percent increase in the chance of graduating.

Yet, the impact by racial and ethnic minorities is similar. PLTW increases the graduation rate by an estimated 4 to 5 percent for African-Americans, Asian/Pacific Islanders, and Hispanic students.

Higher Education Results

Approximately 70% of PLTW students in the 2009 graduating class immediately transitioned into higher education while almost 50% of non-PLTW transitioned to college (see Figure 4). A student is considered to have immediately transitioned if that student began college in the fall of the same year as he or she graduated from high school, and maintained enrollment at that college for at least 30 days and did not withdraw from the college in the fall semester.

Figure 3. Estimated Marginal Effect of PLTW on Graduation Rates by Subgroup: 2009 Cohort

Note: Estimates of the matched cohort using genetic algorithms with a maximum of two non-participants to each participant. Math and science scores derived from the 8th grade Iowa Test of Basic Skills (ITBS), quartiles derived relative to the distribution of the matched cohort, not of all ITBS scores. See table 2.

Among those who immediately transitioned to higher education, more than half of the non-PLTW college students (55%) went to 2-year institutions while the percentage of PLTW college students who chose 4-year institutions was 10% lower. The majority of PLTW and non-PLTW students attended public colleges or universities, with the percentage of PLTW students being slightly higher.

Impact of Project Lead The Way

The descriptive data on higher education transition is, at least, partly attributable to the differences between participants and non-participants before entering PLTW. We used the “matched” set of students to estimate the impact from PLTW while controlling for other variables.

Our findings indicate that PLTW participation increased the probability of immediately attending a two-year college, but had minimal or no impact on attending a 4-year university. The odds of a PLTW student attending college compared to not attending college rose 57 percent compared to similar non-participants. However, the odds of attending a four-year college compared to not attending college did not significantly change with PLTW

participation.

Using the matched cohort sample, which include both PLTW and non-PLTW students, the researchers were able to analyze characteristics of those students and examine the extent to which students’ characteristics related to the probability of the immediate entry into higher education. Students who were on free lunch, which is used as an proxy indicator for a low socio-economic status, were 52 percent less likely to attend a 2 -year college and 65 percent less likely to attend a 4-year college compared to students not on free lunch. Also, students who were receiving some form of accommodation from their school in their learning were almost 2.8 times as likely to attend a 2- year college. Another strong relationship was indicated with Hispanic students in the matched cohort sample. Hispanic students in the sample were 3.8 times more likely than Caucasian students to attend 4-year colleges. As would be expected, students who took higher level mathematics and science courses were much more likely to attend either a 2-year or 4-year college compared to students who did not take the higher level courses.

Figure 4. Transition to Higher Education for PLTW and Non-PLTW students: 2009 Cohort



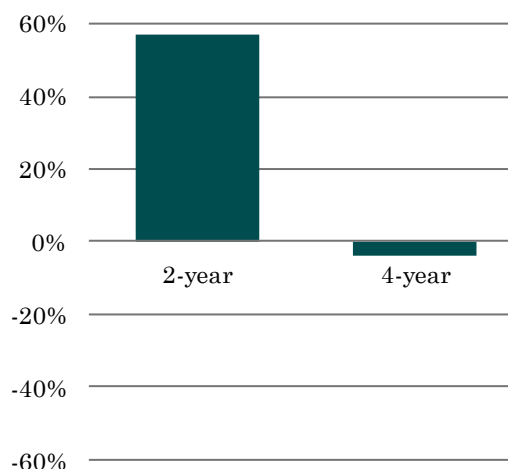
Note: Includes all PLTW and non-PLTW students, is not limited to the “matched” cohort and is subject to selection bias. See table 3.

Conclusions

When accounting for selection biases, both in terms of student demographics as well as academic background, the following conclusions can be made based on the data. Preliminary findings would indicate that PLTW participants showed greater cognitive improvement between 8th and 11th grade especially in mathematics. PLTW participants were more likely to graduate from high school, especially those students who initially scored at the lower levels on their 8th grade assessment. Though, it is not surprising to see these students receiving a larger benefit given there is more opportunity for improvement. A student in the upper quartile with an excellent academic pursuits will be likely to graduate, notwithstanding PLTW participation.

The data also indicates that PLTW participants immediately transitioned at a higher rate to higher education than non-participants, with a significant impact on student enrollment at the community college and minimal impact at the 4-year institution. It was also clear that as would be expected, socio-economic factors and the types of course students challenge themselves with in high school, have a prominent impact on students’ pursuit of higher education. The odds of participants attending 2-year college compared to not attending any college was

Figure 5. Estimates of PLTW Impact on Higher Education Transition by Institutional Type



Note: Estimates of PLTW’s impact shown as difference in odds. Estimates compare the odds of attending an institutional type. See table 4.

57 percent higher compared to non-participants.

Future Directions

Long term impacts of PLTW participation will continue to be examined to answer our research questions and other questions that may arise. This will be accomplished by continuing to examine outcomes such as college attendance, the students’ choice of major, whether it is a STEM major or non-STEM major, as well as the completion of degrees in higher education. Findings of the study have also indicated a relationship between PLTW enrollment and subsequent student enrollment in higher level science and mathematics courses. Future study can focus on the specific potential causes for that relationship, whether it be due to co- and pre-requisite courses associated with PLTW enrollment or through other impacts on the student such as increased student engagement and focus of energy on their education, or through increased self-efficacy. Another area of study may include an examination of students’ transition or transfer from 2-year to 4-year institutions due to the significant number of PLTW participants who attend community colleges. The effectiveness of Project Based Learning may also be examined which could also include

the effectiveness of the professional development programs for PLTW teachers.

Endnotes

1. Iowa Department of Education (2009). *Project Lead the Way Interim Research Report*. Des Moines, IA; Iowa
2. Schenk, T. Jr., Retwisch, D., Laanan, F. S., Chapman, M., Starobin, S. S., & Zhang, Y. L. (2011, September). *Achievement Outcomes of Project Lead The Way: A Study of the Impact of PLTW in Iowa*. Working Paper.
3. Rosenbaum, P. R., & Rubin, D. B. (1983). The central role of the propensity score in observational studies for causal effects. *Biometrika*, 70(1), 41-55. and Rosenbaum, P. R., & Rubin, D. B. (1984). Reducing Bias in Observational Studies Using Subclassification on the Propensity Score. *Journal of the American Statistical Association*, 79(387), 516-524.
4. Schenk, T. Jr., Retwisch, D., Laanan, F. S., Chapman, M., Starobin, S. S., & Zhang, Y. L. (2011, September). *Achievement Outcomes of Project Lead The Way: A Study of the Impact of PLTW in Iowa*. Working Paper.

Table 1. Project Lead The Way Students and Nonparticipants: 2009 Cohort

	Nonparticipants		PLTW Participants	
	(N = 6,583)		(N = 606)	
	Mean	Standard Deviation	Mean	Standard Deviation
Demographics				
Male	0.47	0.50	0.81	0.39
American Indian	0.01	0.08	0.00	0.04
Asian	0.02	0.15	0.02	0.16
Black	0.07	0.26	0.03	0.17
Hispanic	0.06	0.23	0.03	0.17
White	0.84	0.36	0.92	0.28
Economic Status Proxy				
Free Lunch	0.19	0.39	0.10	0.30
Reduced Lunch	0.08	0.27	0.07	0.25
Homeless	0.00	0.07	0.00	0.04
Special Populations				
Section 504	0.01	0.08	0.01	0.09
Gifted & Talented	0.11	0.31	0.20	0.40
IEP	0.14	0.35	0.04	0.21
Testing - 8th Grade ITBS				
Reading - Standard Score	258.96	38.59	272.06	33.55
Reading - Percentile Rank	60.24	27.40	69.83	23.52
Math - Standard Score	259.18	33.54	277.90	28.45
Math - Percentile Rank	60.53	27.02	75.55	21.45
Science - National Standard Score	267.65	35.75	284.57	32.60
Science - Percentile Rank	64.79	24.46	75.96	20.81
High School Graduation				
Graduated within 4 years	0.88	0.33	0.96	0.20

Note: Data for the class of 2009. Testing data reflects national standard score and percentile ranks.

Control group includes students from districts with PLTW, but who did not enroll in any of those courses. High school graduation reflects graduation at any point in high school.

Table 2. Multilevel Logit Regression on High School Graduation: 2009 Cohort

	Genetic One-to-Two		Genetic One-to-One		Nearest Neighbor	
	Estimate	t-statistic	Estimate	t-statistic	Estimate	t-statistic
Intercept (α)	0.00	0.00	-0.65	-0.41	-2.67	-1.90
PLTW Participant	0.64	1.91	0.79	2.39	0.59	2.20
Demographics:						
African-American	-0.53	-1.07	-0.84	-1.49	-0.38	-0.54
Asian/Pacific Islander	-0.69	-1.21	-0.73	-0.90	0.09	0.09
Hispanic	-0.35	-0.60	-0.65	-1.00	-0.32	-0.51
American Indian	14.49	0.01	12.47	0.01	12.51	0.01
Male	-1.37	-3.75	-2.20	-3.36	-1.18	-2.41
Economic Status Proxy						
Free Lunch Eligible	-1.30	-4.97	-1.58	-4.80	-0.84	-2.40
Reduced Lunch Eligible	-1.09	-3.30	-0.89	-1.92	-1.03	-2.57
Homeless	-0.47	-1.17	-1.69	-1.09	13.34	0.01
Special Populations						
IEP	-0.11	-0.09	-0.35	-0.64	0.05	0.12
Section 504 Plan	0.46	1.13	-2.50	-2.15	-0.63	-0.53
Gifted and Talented	13.98	0.01	0.73	1.25	1.05	1.40
8th Grade Testing						
Math	0.02	2.84	0.02	2.59	0.02	2.61
Science	0.01	2.00	0.01	1.16	0.01	1.05
Reading	-0.01	-2.37	-0.01	-0.94	0.00	0.14
Additional Testing Controls:						
Midyear	-0.31	-0.88	-0.58	-1.50	-0.36	-1.25
Spring	-0.42	-0.80	-0.46	-0.77	-0.64	-1.41
Number of Observations	1592		1132		1186	
School Districts	68		50		28	
AIC	781.9		488.4		494.4	
BIC	900.1		599.1		606.1	
LogLikelihood	-368.9		-222.2		-225.2	

Table 3. Transition to Higher Education: 2009 Cohort, All Students

Enrollment	Non-PLTW		PLTW		Total
	Count	Percentage	Count	Percentage	
4-year	4,132	29%	295	33%	4,427
2-year	3,299	23%	336	38%	3,635
No College	6,944	48%	254	29%	7,198
Total	14,375	100%	885	100%	15,260

Table 4. Multilevel Ordered Multinomial Regression of Transition into College: 2009 Cohort

	2-year College		4-year College	
	Odd Ratio	t-statistic	Odds Ratio	t-statistic
PLTW Participant	1.57	2.3	0.94	-0.3
Demographics:				
African-American	1.27	0.43	0.84	-0.24
Asian/Pacific Islander	1.14	0.23	0.72	-0.49
Hispanic	1.1	0.16	3.79	2.11
American Indian	7.8E-07	-8.8E+07	3.6E-07	-1.05E+08
Male	0.58	-2.15	0.64	-1.74
Economic Status Proxy				
FreeLunch	0.48	-2.56	0.35	-2.9
Reduced Lunch	0.88	-0.35	0.5	-1.54
IEP	1.08	0.15	0.74	-2.45
Section504	2.77	1.53	0.18	-10.41
Special Populations				
Gifted/Talented	0.82	-0.62	0.76	-0.99
Homeless Status	0.82	-3.21	0.67	-8.42
8th Grade ITBS Standard Scores				
Reading	1	0.68	1.02	3.08
Math	1	0.44	1.01	2.19
Science	1	-0.83	1	-0.64
Science Courses				
Earth Sciences	1.38	2.39	1.07	0.45
Biology	1.04	0.28	1.01	0.07
Chemistry	1.47	2.06	2.16	3.63
Physics	1.02	0.11	1.64	2.74
Science/Engineering/Tech. Sciences	1.38	1.01	2.25	2.34
Mathematics Courses				
Geometry	0.94	-0.33	0.82	-0.86
Algebra 1	1.06	0.35	0.86	-0.78
Algebra 2	0.61	-2.65	1.09	0.42
Algebra 3/Trig	1.69	2.25	2.15	3.3
Precalculus	1.23	0.72	1.49	1.45
Calculus	2.53	3.07	4.87	5.44
Probability and Statistics	1.05	0.21	0.72	-1.23
I.B. Mathematics	0.78	-0.66	2.01	2.2
Business/Technical Mathematics	0.9	-0.4	0.5	-1.3
Other Mathematics	0.46	-2.09	1.07	0.22
Graduation				
High School Graduate	1.98	2.01	0.15	-5.14

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